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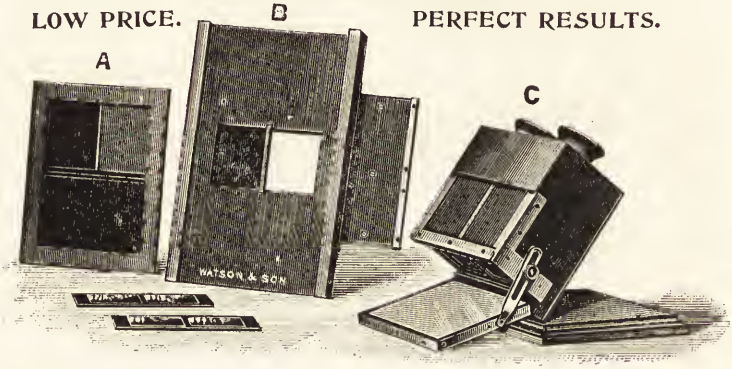

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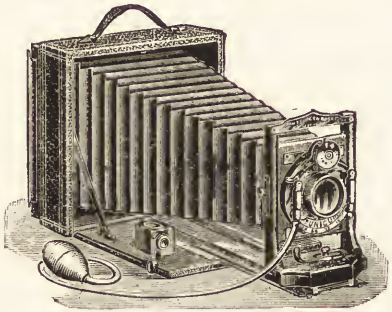

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CARBON PRINTING

BY

E. J. WALL

AUTHOR OF

"THE DICTIONARY OF PHOTOGRAPHY."

WITH A CHAPTER ON MR. THOS. MANLY'S "OZOTYPE" PROCESS

[THE AMATEUR PHOTOGRAPHER'S LIBRARY, No. 8.]

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CARBON PRINTING.

INTRODUCTION.

In order to make *The Amateur Photographer's Library* as complete as possible, this small work on Carbon Printing has been written, the main object being to provide, in convenient form for reference, historical and practical notes on the subject, and it is hoped that this work may induce greater attention to this the most permanent of all printing processes.

HISTORICAL NOTES.

In 1798 Vauquelin discovered chromium and chromic acid, and stated that the latter formed with nitrate of silver a carmine red salt which turned purple red by the action of light.* Eder states †

* "Sur une Nouvelle Substance Metallique," *Annales de Chimie*, 1798, xxv., p. 21.

† "Handbuch der Photographie," Band i., Heft. 1, p. 51. "Ich erinnere daran, dass Ponton 1839, offenbar an

that he believes that Mungo Ponton knew of Vauquelin's researches, and thus was led to discover the sensitiveness of the bichromate of potash in contact with paper.

In 1832, Dr. Gustav Suckow, Professor of Jena, published a work on "Die Chemischen Wirkungen des Lichtes," which contains the statement that bichromate of potash in contact with organic matter is reduced by light and gives a green colour.*

In 1839, Mungo Ponton† discovered that ordinary writing paper soaked in solution of bichromate of potash was sensitive to light and turned brown in those parts exposed to the solar rays.

In 1840, E. Becquerel‡ obtained prints by strongly sizing paper with starch and saturating

Vauquelin's Angabe anknupfend, die Lichtempfindlichkeit des Silberchromates photographisch verwerthen wollte und dabei die Lichtempfindlichkeit des Kalium bichromates auf Papier entdeckte."

* Eder's "Handbuch der Photographie," Band i., Heft. 1, p. 95, gives the actual passage, which is as follows: "Setzt man eine Auflösung von zweifach chromsaurem Kali und zweifach Schwefelsaurem Kali der Einwirkung des Sonnenlichtes aus und bestreut das efflorescirte Salz an verschiedenen Stellen mit gepulvertem Zucker, so bildet sich die schönste farbige Moosvegetation. . . . Durch die Beleuchtung wird nämlich in diesem Processe ein Theil des Säurestoffs der Chromsaüre ausgeschieden, so dass dadurch grünes chromsäuerliches Kali gebildet wird."

† *Edin. New Philos. Jour.*, 1839, p. 169.

‡ *Comptes Rendus*, x., p. 469.

same with bichromate of potash, exposing to light and treating the paper with tincture of iodine, when a blue image was obtained. The prints were then washed in water for some little time, dried between blotting-paper, and treated with a varnish of gum water. Becquerel says in explanation, "Voici le détail et l'explication de ce procédé : ayant employé différentes sortes de papiers enduits de bichromate, je reconnus qu'ils n'étaient pas tous aptes à produire rapidement les dessins ; que le mode de collage influait sur leur coloration à la lumière, et qu'avec du papier non collé cette coloration ne s'effectuait qu'à la longue ; dès lors je m'aperçus que la principale réaction avait lieu de l'acide chromique contenu dans le bichromate sur l'amidon qui entrait dans la colle du papier ; alors comme l'amidon a la propriété de former avec l'iode une combinaison d'un très beau bleu, je pensai que sur les parties du papier qui n'avaient pas été exposées à l'action des rayons solaires, l'amidon ne s'étant pas combiné avec l'acide chromique, l'iode devait former l'iodure bleu et représenter ainsi les ombres par des ombres."

Further on Becquerel admits his inability to obtain pictures in the camera : "Les essais que j'ai tentés pour reproduire les images de la chambre obscure au moyen de ce papier impressionable, n'ayant pas encore donné de résultats satisfaisants, je n'en entretiendrai pas l'Académie."

In August 1843, Hunt* suggested his chromatype process, which consisted of washing good writing-paper over with sulphate of copper in solution, and then, when dry, with bichromate of potash solution, and exposing to light.

Fox Talbot† in 1853 addressed a letter to the Académie des Sciences, Paris, called "Gravure Photographique sur l'Acier," in which he describes the use of gelatine impregnated with bichromate of potash for obtaining an image which could be applied to a steel plate, developed, and the plate etched with an etching liquid. This is essentially the first note of the property of chromatised gelatine becoming insoluble in light.

Pretsch in June 1855 utilised this property of bichromated gelatine for various photo-mechanical processes; and Poitevin also worked on the same lines.

But to Poitevin‡ must be given the honour of being the actual inventor or discoverer of the carbon process proper—that is, of the process of preparing photographic prints by exposing a sheet of paper coated with bichromated gelatine, impregnated with some colouring matter.

* Hunt's "Researches on Light," 1854, p. 175; Dingler's *Polytechnic Journal*, xc., p. 413. *Athenæum*, 1843, No. 826; *Brit. Assoc. Adv. Scien.*, Section B., Aug. 17th, 1843.

† *Comptes Rendus*, xxxv., p. 780.

‡ "Brevets de 1855."

Whilst we acknowledge Poitevin as the pioneer it must not for one moment be supposed that he was the inventor of the process. He laid the foundation, and others improved and built upon the foundation thus laid.

Poitevin's prints were practically devoid of all half-tones, because the light had acted more or less only on the surface of the bichromated gelatine, thus leaving the supporting portions soluble; and dissolve they did, carrying away practically all half-tone.

The cause of this defect was pointed out by Abbé Laborde,* and confirmed by Fargier,† who suggested as a remedy the placing of the paper in contact with the negative, so that the light, having passed through the negative, would also pass through the paper, and then act on the gelatine and render it insoluble, and thus preserve the half-tones. The fault of this process was obviously that the grain of the paper was impressed on the image. To get over this difficulty Fargier spread his bichromated gelatine on glass, and when dry exposed to light under a negative, and then coated the film

* "Bulletin de la Société française de Photographie," 1858, p. 213.

† "Bulletin de la Société française de Photographie," 1860, p. 314.

with collodion and placed the whole in cold water to swell; when the film had absorbed water it was placed in warm water, the gelatine not acted upon by light was dissolved, and the image was left floating on the collodion film and could be transferred to glass or paper. Any of our readers who have stripped a negative in the ordinary way will know it is by no means a process which a rough or heavy-handed operator can use, and the delicacy of this process of Fargier's was against its general use.

In 1857 M. Testud de Beauregard patented a process somewhat similar to Poitevin's; but in Beauregard's process the pigment was applied to the surface of the chromated gelatine (before exposure), not mixed with it, the idea being to keep the whites pure.

In 1858 Mr. Pouncy showed at the London Photographic Society some prints in carbon, but kept their method of preparation secret. Mr. Portbury in a letter * claimed that Mr. Pouncy's prints were produced by him when he was Mr. Pouncy's apprentice. Subsequently Pouncy's process was patented, and the specification runs as follows:—"I coat the paper or surface which is to receive the picture with a composition of vegetable carbon, gum-arabic, and bichromate of potash, and on to

* *Photographic News*, Nov. 23rd, 1860.

this prepared surface I place the negative picture, and expose to light in the usual way. Afterwards the surface is washed with water, which dissolves the composition at those parts on which the light has not acted, but fails to affect those parts of the surface on which the light has acted. Consequently, on those parts of the surface the colouring matter remains in the state in which it was applied, having experienced no chemical change. Sometimes for the vegetable carbon I substitute bitumen, or other colouring matter may be employed. By this process, pictures are not liable to fade like ordinary photographs."

In 1858 MM. Garnier and Salmon suggested a sort of modified powder process in which plumbago, lampblack, or pigment in a fine state of division was applied to the film. M. Gabriel de Rumine also described a somewhat similar process to Poitevin's, and M. Brebisson a little later proposed a method of applying the colour after exposure. Seeley, editor of the *American Journal of Photography*, proposed the application of gum, carbon, and bichromate to paper, but abandoned it on hearing that it was previously discovered by Poitevin.

In 1859 the Duc de Luynes' prize of £80 for a process of producing permanent prints was divided between Beauregard, Garnier and Salmon, and

Pouncy, and the following is the report of the commission on this subject :—

"The common and primary source, the unique germ of all the processes, from which we have selected those which appeared to us worthy of reward, that is to say, of all the carbon processes, is incontestably that of M. Poitevin ; and consequently, the common father of all these inventors is M. Poitevin. A few words will convince you of this. In the month of August 1855, M. Poitevin deposited at the office of the Prefect of the Seine the description of a process of photographic printing. The 15th of February of the following year, having modified it on certain points, he brought it to you. What, now, was this method reduced to its most simple expression? In August 1855, application on the paper of a mixture of bichromate of potash, organic substances, and colouring matter, at one operation, before insolation. In February 1856, application of the same substances, but in two operations—to wit, the bichromate and the organic body before, and the colouring matter or carbon after insolation. In both cases, washing in distilled water, to complete and fix the proof.

"Now if we follow the chronological order of the presentation, what shall we see? M. Testud de Beauregard in December 1857 communicated a process to you of which the following is the *résumé* :

the use of bichromate of potash, of an organic substance, and colouring matter (carbon). Only here the complete preparation which always precedes insolation is separated into two parts: first, immersion of the paper in the mixture of bichromate and organic matter ; drying, and then the spreading of the carbon. After insolation, the washing in common water. The manipulation alone varies ; the principle is identical.

" In January 1858 Mr. Sutton published a method of obtaining durable positives; this again was exactly the Poitevin method, for it contained nothing more than this : application on the paper of a mixture of bichromate of potash, organic substance, and pulverised charcoal, drying, insolation, and washing. On his own part Mr. Sutton added an alkaline solution for clearing the image if necessary.

" The 10th of April, 1858, Mr. Pouncy took out a patent in England, which was not published in that country till November, and in our *Bulletin* till the following month. If we isolate the constituent elements, we find in substance application on the paper of a mixture of bichromate of potash, gum-arabic, and vegetable charcoal, in a single operation before insolation; afterwards washing in distilled water.

" Finally, to conclude this long review, on the

30th of June, 1858, MM. Garnier and Salmon deposited in the hands of your secretary a paper containing a process which, more or less modified by them in the interval, led to our being made witnesses of experiments in which the use of alkaline bichromate, of an organic body, and of carbon, reproduced with more or less trifling variations a series of causes and effects which had their type in M. Poitevin's process—so that we might almost say in truth that, if M. Poitevin had not existed, each of these gentlemen would have invented it. Is it possible, we ask you, in the presence of this severe but impartial analysis, to deny that these products of different origins ought all to bear in some sort a common trade mark? And if we give prominence to some in our photographic world by stamping them with a seal of honour, means should be found of associating very prominently, and even in the foremost place, the name of the initiator."

Poitevin, it seems, had also recognised the defect in the carbon process and its cause.*

In 1858 Burnett,† in speaking of this subject, says :—

"It must be observed that the possibility of

* "Traité de l'Impression Photographique sans Sel d'Argent," p. 71.

† *Journ. Phot. Soc.*, vol. v., p. 84.

producing half-tones by this plan rests on the power of the insolubility—causing actinism to penetrate, with a certain degree of facility, the mixture of pigment with bichromate and gelatine or gum, the gelatine or gum being in consequence rendered insoluble, to a greater or less depth on different parts of the picture according to the varying depth to which the actinism has been allowed or had time to penetrate ; this, again, being dependent on the varying translucency of the different parts of the negative."

At this period Mr. Swan commenced his experiments and tried first of all coating a glass plate with bichromated gum and lampblack, and after exposure the plate was washed with water to remove the unacted-upon gum.

In 1859 Blair of Perth * independently recognised the cause of loss of half-tone in carbon printing. Having applied bichromated gum and carbon to paper, he states that after exposure "the outer crust was more sunned and hardened than the inner," and that by steeping the latter was washed away and carried the outer with it. He therefore exposed through the paper, and tried wax paper.

M. Joubert in 1859 discovered a process which he called "phototype," and examples of the same appeared in the *Journal of the Photographic*

* "Photographic Notes," vol. iv., p. 331.

Society for June 1860, but no details were ever published.

In 1863 Pouncy patented a process of producing pictures in fatty inks by the aid of bitumen or bichromate, etc.

In 1864 Swan * made what was the greatest improvement and we may say the final improvement, for all since have been merely matters of detail. The process was finally published by Swan, April 15th, 1864.† In a paper read before the Edinburgh Society in 1863, Mr. Davies stated he had transferred carbon prints, but the details were not published till July 1864, after Swan's process had been patented.

The best description of Swan's process is contained in his patent specification, which we give in its entirety.

"My invention relates to that manner or style of photographic printing known as carbon, or pigment printing. In this style of printing, carbon or other colouring matter is fixed by the action of light passing through a negative, and impinging upon a surface composed of gelatine, or other like substance, coloured with carbon or other colouring matter, and made sensitive to light by means of bichromate of potash, or bichromate of ammonia,

* *Photc. Journal*, March 15th, 1864, p. 2.

† *Photo. News*, 1864, p. 85.

or other chemical substance having like photographic property ; those portions of the coloured and sensitive gelatinous surface which are protected from the light by the opaque or semi-opaque portions of the negative being afterwards washed away by means of water, while the parts made insoluble by light remain, and form a print. This kind of photographic printing, although possessing the advantage of permanency, and affording the means of insuring any required tone or colour for the print, has not come into general use, because of the difficulties hitherto experienced in obtaining by it delicacy of detail, and complete gradation of light and shade.

"The difficulties referred to were more particularly experienced in attempts to employ paper coated with the coloured gelatinous material, and arose from the fact that, in order to obtain half-tone, certain portions of the coloured coating lying behind or at the back of the photographically impressed portions required to be washed away, and the employment of paper in the way it has been employed hitherto, not only as a means of supporting the coloured coating, but also to form ultimately the basis or groundwork of the print, obstructed the removal of the inner or back portions of the coloured coating, and prevented the obtaining of half-tone.

"Now, my invention consists in the formation of tissues adapted to the manner of printing referred to, and composed of, or prepared with, coloured gelatinous matter, and so constructed, that while they allow, in the act of printing, free access of light to one surface of the coloured gelatinous matter, they also allow free access of water, and the unobstructed removal of the non-affected portions of the coloured matter from the opposite surface, or back, in the act of developing ; and I obtain this result either by the disuse of paper altogether, or by the use of it merely as a backing, or temporary support, of the coloured gelatinous matter ; the paper so used becoming entirely detached from the coloured gelatinous matter in the act of developing, and forming no part of the print ultimately.

"My invention consists, furthermore, in the special mode of using the said tissues, whereby superior half-tone and definition in the print are obtained as aforesaid, and also in a mode of transferring the print after developing from a temporary to a permanent support, so as to obtain a correction in the position of the print in respect of right and left. In producing the photographic tissues referred to, I form a solution of gelatine ; and for the purpose of imparting pliancy to the resultant tissue, I have found it advisable to add to the gelatine

solution, sugar or other saccharine matter, or glycerine. To the said gelatinous solution I add carbonaceous or other colouring matter, either in a fine state of division, such as is used in water-colour painting, or in the state of a solution or dye, or partly in a fine state of division, and partly in solution.

"With this coloured gelatinous solution I form sheets or films, as hereafter described, either at the time of their formation, by introducing into the gelatinous compound bichromate of ammonia, or other agent of like photographic properties, or by applying to such non-sensitive sheets or films, after their formation, a solution of the bichromate, or other substances of like photographic property. This latter method I adopt when the sheet or film is not required for use immediately after its formation. I will, in my future references to the bichromate of ammonia or the bichromate of potash, or to other chemicals possessing analogous photographic properties, denominate them 'the sensitiser'; and in referring to the coloured gelatinous solution, I will denominate this mixture 'the tissue-compound.' When the tissue to be produced is required for immediate use, I add the sensitiser to the tissue-compound; but where the tissue is required to be preserved for some time before using, I prefer to omit the sensitiser from

the tissue-compound, with a view to the tissue being made sensitive to light subsequently, by the application of a solution of the sensitiser.

"With respect to the composition of the tissue-compound, it will be understood by chemists, that it may be varied without materially affecting the result, by the addition or substitution of other organic matters, similarly acted upon by light, when combined with a salt of chromium, such as I have referred to. Such other organic matters are gum-arabic, albumen, dextrine; and one or more of these may be employed occasionally to modify the character of the tissue-compound, but I generally prefer to make it as follows:—I dissolve, by the aid of heat, two parts of gelatine in eight parts of water, and to this solution I add one part of sugar, and as much colouring matter in a finely divided state, or in a state of solution, or both, as may be required for the production of a photographic print with a proper gradation of light and shade. The quantity required for this purpose must be regulated by the nature of the colouring matter employed, and also by the character of a negative to be used in the printing operation. Where it is desired that the colouring matter of the print should consist entirely, or chiefly, of carbon, I prefer to use lampblack finely ground and prepared as for water-colour painting, or I use

Indian ink; and where it is desired to modify the black, I add other colouring matter to produce the colour desired. For instance, I obtain a purple black by adding to the carbon indigo and crimson lake, or I add to the carbon an aniline dye of a suitable colour; where the colouring matter used is not a solution or dye, but solid matter in a fine state of division, such as Indian ink or lampblack, I diffuse such colouring matter through water, or other inert liquid capable of holding it in suspension; and after allowing the coarser particles to subside, I add, of that portion which is held in suspension, as much as is required, to the gelatine solution. In preparing tissue to be used in printing from negatives technically known as 'weak,' I increase the proportion of colouring matter relatively to that of the tissue-compound; and I diminish it, for tissue or paper to be used in printing from negatives of an opposite character.

"Having prepared the tissue-compound as before described, I proceed to use it as follows:—For preparing sensitive tissue, I add to the tissue-compound more or less of the sensitiser, varying the quantity added, according to the nature of the sensitiser, and to the degree of sensitiveness to be conferred on the tissue to be produced from it. For ordinary purposes, and where the tissue-compound is made according to the formula before given, I add

about one part of a saturated solution of bichromate of ammonia to ten parts of the tissue-compound; and I make this addition immediately previous to the preparation of the tissue, and I maintain the tissue-compound in the fluid state, by means of heat, during the preparation of the tissue, avoiding the use of an unnecessary degree of heat; I also filter it through fine muslin or flannel, or other suitable filtering medium, previous to use; and I perform all the operations with the tissue-compound, subsequent to the introduction of the sensitiser, in a place suitably illuminated with yellow or non-actinic light. In forming tissue upon a surface of glass, I first prepare the glass, so as to facilitate the separation of the tissue from it. For this purpose, I apply ox-gall to the surface of the glass (by means of a brush, or by immersion), and allow it to dry. The glass is then ready for coating with the tissue-compound, or I apply to the glass a coating of collodion, previous to the application of the coating of tissue-compound. In this case, the preparation with ox-gall is unnecessary. When collodion is used, the collodion may consist of about ten grains of pyroxyline in one ounce of mixture of equal parts of sulphuric ether and alcohol. I apply the collodion by pouring it on the surface to be coated, and draining off the excess, and I allow the coating of collodion to become dry before applying the coating of tissue-

compound. I generally use a plane surface on which to form the tissue, but surfaces of a cylindrical or other form may be sometimes used advantageously. In preparing sheets of sensitive tissue on a plane surface of glass, I prefer to use the kind of glass known as plate, or patent plate. Before applying the sensitive tissue-compound, I set the plate to be coated so that its upper surface lies in a horizontal position, and I heat the plate to about the same temperature as the tissue-compound, that is, generally, to about 100° Fahr. The quantity of the tissue-compound that I apply to the glass varies with circumstances, but is generally about two inches to each square foot of surface coated. After pouring the requisite quantity of the tissue-compound upon the surface of the plate, I spread, or lead the fluid by means of a glass rod, or soft brush, over the entire surface, taking care to avoid the formation of air bubbles ; and I keep the surface in a horizontal position, until the solidification of the tissue, compound. In coating other than plane surfaces I vary, in a suitable manner, the mode of applying the tissue-compound to such surfaces. In coating a cylindrical surface, I rotate the cylinder in a trough containing the tissue-compound, and after having produced a uniform coating, I remove the trough, and keep up a slow and regular rotation of the cylinder until the coating has solidified. After

coating the surface of glass or other substance as described, I place it in a suitable position for rapid drying, and I accelerate this process by artificial means, such as causing a current of dry air to pass over the surface coated, or I use heat, in addition to the current of air, or I place it in a chamber containing quicklime, chloride of calcium, or other substance of analogous desiccating property. When the tissue is dry, I separate it from the surface on which it was formed, by making an incision through the coating to the glass, around the margin of the sheet; or I cut through the cylindrical coating near the ends of the cylinder, and also cut the coating across, parallel with the axis of the cylinder, when, by lifting one corner, the whole will easily separate in a sheet. Where the tissue-compound is applied over a coating of collodion, the film produced by the collodion, and that produced by the tissue-compound, cohere, and the two films form one sheet. Sometimes, before the separation of the coating from the glass, I attach to the coating a sheet of paper, for the purpose of strengthening the tissue, and making it more easy to manipulate. I generally apply the paper, in a wet state, to the dry gelatinous surface; and having attached the paper thereto in this manner, I allow it to dry; and I then detach the film and adherent paper from the glass by cutting round the margin of the sheet and lifting

it off as before described. Where extreme smoothness of surface, such as is produced by moulding the tissue on glass, as described, is not of importance, and where greater facility of operation is desired, I apply a thick coating of the tissue-compound to the surface of a sheet of paper. In this case the paper is merely used as a means of forming and supporting temporarily the film produced from the tissue-compound; and such paper separates from the gelatinous coating in a subsequent stage of my process. In coating a surface of paper with the sensitive tissue-compound, I apply the sheet, sometimes of considerable length, to the surface of the tissue-compound contained in a trough, and kept fluid by means of heat, and I draw or raise the sheet or length of paper off the surface with a regular motion; and I sometimes apply more than one coating to the same sheet in this manner. After such coating, I place the coated paper where it will quickly dry, and seclude it from injurious light.

"The sensitive tissue, prepared as before described, is, when dry, ready to receive the photographic impression, by exposure under a negative in the usual manner, or by exposure in a camera obscura to light transmitted through a negative in the manner usual in printing by means of a camera. I prefer to use the sensitive tissue within two days of the time of its preparation. Where the tissue is

not required for immediate use, I omit the sensitiser from the tissue-compound, as before mentioned; and with this non-sensitive tissue-compound, I coat paper, glass, or other surface, as described in the preparation of the sensitive tissue or paper. In preparing sheets of non-sensitive tissue by means of glass as described, I use no preliminary coating of collodion. I dry the non-sensitive tissue in the same manner as the sensitive, except that in the case of the non-sensitive tissue, seclusion from daylight is not necessary.

"The non-sensitive tissue is made sensitive, when required for use, by floating the gelatinous surface upon a solution of the sensitiser, and the sensitiser that I prefer to use for this purpose is an aqueous solution of the bichromate of potash containing about two and a half per cent. of this salt. I apply the sensitiser (by floating or otherwise) to the gelatinous surface of the tissue; and after this I place it in a suitable position for drying, and exclude it from injurious light.

"In applying to photographic printing the various modifications of the sensitive tissue, prepared as before described, I place the sensitive tissue on a negative in an ordinary photographic printing frame, and expose to light in the manner usual in photographic printing; or I place it in a camera obscura in the manner usual in printing

by means of a camera obscura. When the tissue employed is coated with a film of collodion on one side, I place the collodionised side in contact with the negative ; or where it is used in the camera, I place the collodionised side towards the light passing through the camera lens. Where the tissue is not coated with collodion, and where paper forms one of the surfaces of the tissue, the other surface being formed of a coating or film of the tissue-compound, I place this last-named surface in contact with the negative ; or when using it in the camera, I present this surface towards the light transmitted by the lens. After exposure for the requisite time, I take the tissue from the printing frame or camera, and mount it in the manner hereinafter described—that is to say, I cement the tissue, with its exposed surface, or, in other words, with that surface which has received the photographic impression, downward, upon some surface (usually of paper) to serve temporarily as a support during the subsequent operation of developing, and with a view to the transfer of the print, after development, to another surface ; or I cement it (also with the exposed or photographically impressed surface downwards) upon the surface to which it is to remain permanently attached. The surface on which it is so mounted may be paper, card, glass, porcelain, enamel, etc. Where the

tissue has not been coated with collodion previous to exposure to light, I prefer to coat it with collodion on the exposed or photographically impressed side, before mounting it for development, but this is not absolutely necessary; and I sometimes omit the coating with collodion, more particularly where the print is intended to be coloured subsequently. Or where I employ collodion, with a view to connect the minute and isolated points of the print firmly together, during development, I sometimes ultimately remove the film it forms by means of a mixture of ether and alcohol, after the picture has been finally mounted, and the support of the film of collodion is no longer required. In mounting the exposed tissue or paper previous to development, in the temporary manner, with a view to subsequent transfer to another surface, I employ, in the mounting, a cement that is insoluble in the water used in the developing operation, but that can be dissolved afterwards, by the application of a suitable solvent; or one that possesses so little tenacity, that the paper or other support, attached temporarily to the tissue or paper by its means, may be subsequently detached without the use of a solvent.

"The cements that may be used for temporary mounting are very various, but I generally prefer to use a solution of india-rubber, in benzole or other

solvent, containing about six grains of india-rubber in each ounce of the solvent, and I sometimes add to the india-rubber solution a small proportion of dammar-gum, or gutta-percha. In using this cement, I float the photographically impressed surface of the tissue upon it, and I treat in a similar manner the paper or other surface intended to be used as the temporary mount or support during development; and after allowing the benzole or other solvent to evaporate, and while the surfaces coated with the cement are still tacky, I press them strongly together in such a manner as to cause them to cohere.

"When the photographically impressed but still undeveloped tissue is to be cemented to a surface, that not only serves to support the picture during its development, but also constitutes permanently the basis of the picture, I prefer to use albumen, or starch paste as the cementing medium; and where I employ albumen, I coagulate, or render it insoluble in water (by means of heat, by alcohol, or other means), after performing the cementing operation, and previous to developing. In the permanent as in the temporary mode of mounting, I cement the tissue, with its photographically impressed surface downward, upon the surface to which it is to be permanently attached. After mounting the tissue, as before described, and allow-

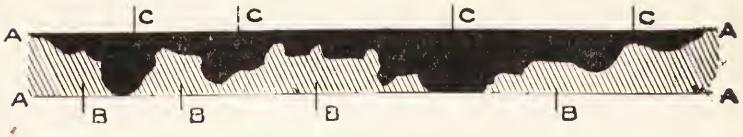
ing the cement used time to dry, where it is of such a nature as to require it, I then submit the mounted tissue to the action of water, sufficiently heated to cause the solution and removal of those portions of the coloured gelatinous matter of the tissue which have not been rendered insoluble by the action of light during exposure in the printing frame or camera. Where paper has been used as a part of the original tissue, this paper soon becomes detached by the action of the warm water, which then has free access to the under stratum or back of the coloured gelatinous coating, and the soluble portions of it are therefore readily removed by the action of the water ; and by this means the impression is developed, that was produced by the action of light during the exposure of the tissue in the printing frame or camera, and the picture remains attached to the mount, cemented to the photographically impressed surface previous to development. I allow the water to act upon the prints during several hours, so as to dissolve out the decomposed bichromate as far as possible. I then remove them from the water, and allow them to dry, and those not intended for transfer, but that have been permanently attached to paper, previous to development, I finish by pressing and trimming in the usual manner. Those which have been temporarily mounted, I transfer to paper, card, or

other surface. In transferring to paper or card, I coat the surface of the print with gelatine, gum-arabic, or other cement of similar character, and allow it to dry. I then trim the print to the proper shape and size, and place its surface in contact with the piece of paper or card to which the transfer is to be effected, such piece of paper or card having been previously moistened with water, and I press the print and mount strongly together ; and after the paper or card has become perfectly dry, I remove the paper or other supporting material, temporarily attached, previous to development, either by simply tearing it off, where the cement used in the temporary mounting is of a nature to allow of this without injury to the print, or I apply to the temporary mount benzole or turpentine, or other solvent of the cement employed, or I immerse the print in such solvent, and then detach the temporary mount, and so expose the reverse surface of the print, and after removing from the surface of the print, by means of a suitable solvent, any remains of the cement used in the temporary mounting, I finish the print by pressing in the usual manner. If, however, the print be collodionised, and be required to be tinted with water colour, I prefer to remove the collodion film from the surface of the print, and this I do by the application of ether and alcohol.

"Having now set forth the nature of my invention of 'Improvements in Photography,' and explained the manner of carrying the same into effect, I wish it to be understood, that under the above in part recited letters patent, I claim :—

"First, the preparation and use of coloured gelatinous tissues, in the manner and for the purpose above described.

"Secondly, the mounting of undeveloped prints, obtained by the use of coloured gelatinous tissues, in the manner and for the purpose above described.



"Thirdly, the remounting or transference of developed prints, produced as above described, from a temporary to a permanent support."

It will be seen, then, that the whole secret of the process lay in preparing "a tissue" which could be exposed to light under a negative in the ordinary way and then attached to some support and developed from the back, leaving the half-tones entire.

The above diagram may help to make things clear as to the action of light on bichromated gelatine or any colloid body. Let A A A A represent the film of bichromated gelatine, after exposure under a negative, then C C C C will represent that portion

which has been rendered insoluble by the action of light, and B B B B that portion which is still soluble. In some places it will be noted the light action has penetrated right through the film, but in others only partially so, and to develop it in the position as shown above it is more than likely that those portions of the film representing half-tone will break away in development when the unacted-on gelatine, B B, underneath is dissolved.

PREPARING THE NON-SENSITIVE TISSUE.

The tissue is prepared by machinery in large establishments, and I strongly recommend my readers to purchase their tissue ready prepared. Although I have, for purely experimental purposes, prepared my own tissue, it is far more costly, more troublesome, and more messy. Commercially, paper in endless bands is passed over the surface of a trough of pigmented gelatine, which is kept at an even temperature by the aid of steam.

The pigmented gelatine is prepared as follows :— A plain "jelly" is first prepared from some formulæ such as the following, the first of which was given by Jeanrenaud.* The following quantity of jelly is sufficient to coat a length of paper 3 m. 60 cm. × 0 m. 76 cm. (= 132 × 30 ins.).

* "Bull. de la Soc. franç.," 1872, pp. 31, 70, 103.

PLAIN JELLY.

Nelson's gelatine ...	25 g.	or 386 grs.
Amber „ ...	200 „	3100 „
Water	675 cc.	or 24 oz.
Sugar	30-60 g.	or 460-920 grs.
Dry soap	25 g.	or 386 grs.

The gelatine is soaked in the water, dissolved by the aid of a gentle heat, and the sugar and soap added ; the whole carefully filtered and mixed with the colouring-matter.

REDDISH BROWN (PHOTOGRAPHIC TINT).

Indian red	10 g.	or 154 grs.
Carmine lake	6 „	92½ „
Chinese ink	8 „	123 „

CHOCOLATE BROWN.

Chinese ink (stick) ...	3 g.	or 46 grs.
Dry hydrated peroxide of iron	2 „	31 „
Alizarine dissolved in soda	0·5 „	7½ „
Purpurine	0·5 „	7½ „

ENGRAVING BLACK.

Lampblack	3·8 g.	or 58·6 grs.
Carmine lake	4 „	62 „
Indigo	2 „	31 „

WARM BLACK.

Lampblack ...	...	...	6 g. or 92 grs.
Carmine lake	...	...	6 „ 92 „
Burnt umber	...	...	4 „ 62 „
Indigo ...	...	...	2 „ 31 „

DARK BROWN.

Indigo ...	...	...	2·5 g. or 39 grs.
Indian red ...	...	...	6 „ 92 „
Carmine lake	...	...	1·25 „ 19 „
Vandyke brown	...	...	4 „ 62 „
Lampblack	...	...	30 „ 462 „

RED BROWN.

Chinese ink	...	...	6 g. or 92 grs.
Carmine lake	...	...	8 „ 123 „
Vandyke brown	...	...	8 „ 123 „

SEPIA.

Lampblack	...	...	4 g. or 62 grs.
Sepia de Cologne ...		...	35 „ 540 „

RED TRANSPARENCY.

Carmine lake	...	...	10 g. or 154 grs.
Indian red ...	...	...	6 „ 92 „
Chinese ink	...	...	4 „ 62 „

The pigment or colouring-matter is in as fine a state of division as it is possible to get it, and after being sifted is placed on a large sheet of ground plate glass, and a little of the warm "plain jelly" poured into the middle, and worked about with a muller till absolutely smooth; then the rest of the jelly is added, and the paper coated.

Burton * gives the following directions:—

"The following formula is due to Adolph Ott, at one time chemist to Messrs. Braun & Co., Dornach, one of the largest workers of the carbon process in the world. It has given successful results in the hands of the writer:—

Gelatine	... 100 parts
Sugar candy	... 25 ,,
Glycerine (when necessary)	... 5 ,,
Potassium bichromate (dissolved in 50 parts of water)	... ... 5 ,,
Water	... 300 to 400 ,,
Colouring-matter ...	... 2 to 5 ,,

"The above is the formula exactly as given by Ott. The following is the modification used by the writer, and the exact manner of mixing the 'jelly':—

Nelson's opaque gelatine ... ... ½ lb.

* "Practical Guide to Photographic and Photo-mechanical Printing Processes" (published by Marion).

Coignet's gold label gelatine	2 oz.
White loaf sugar	3 „
Glycerine (none for any climate the writer has had any experience of, and a thing to be avoided if possible).	
Potassium bichromate (dissolved in 5 ounces of water, and converted into double chromate of potassium and ammonium by adding liquid ammonia till the solution smells distinctly of it)	½ oz.
Water	2 pints
Colouring-matter, quantum suff., as to be hereafter described.	

"As to the colouring-matter that may be used there is almost an endless variety. For all common work, however, lampblack in some form is used as the body of the colour. Any form of lampblack may be used—as, for example, 'ivory black.' It is probable that for work on a small scale, at least, there is nothing so good as 'Chinese ink.' It is with this that all the writer's experiments have been made. 'Chinese ink' is merely a very fine quality of lampblack suspended in a sort of gelatine or in a gum ; and even the inferior varieties, which can be bought very cheaply, are good enough for all

kinds of carbon-work, except such as the making of lantern slides. These being subjected to great magnification, it is advisable, if they are made by the carbon process, to use a fairly high quality of 'Chinese ink.' A quantity of the ink is broken into fragments by a hammer—not a very easy thing, for the ink is very hard—and is placed in a cup, and left covered with cold water for twenty-four hours. Any time after this the ink can easily be melted by the application of heat, forming a thick black paste.

"When it is wanted to mix up the jelly, the gelatine is covered with water, and is allowed to soak for an hour or two. Heat is then applied to melt it, and the sugar is added. This latter is very readily melted by a little stirring. Next comes the pigment. The Chinese ink paste having been melted by heat, is added little by little to the gelatine with much stirring. The colour is tested from time to time in the following way:—A small strip of thinnish white paper—common writing-paper, for example—is floated for a moment on the surface of the jelly, and is then removed. It is held by one end till all the jelly that will run off of itself has run off, and it is then examined by looking through it at a lamp. The addition of the pigment should be continued till the little bit of sample tissue that has been made appears quite

opaque. For 'transparency tissue' the addition should be continued till there is about 50 per cent. more pigment in the jelly than is necessary to produce opacity."

SENSITISING THE TISSUE.

The tissue may be obtained commercially, and the various colours are: standard brown, warm brown, sepia, warm black, engraving black, standard purple, Bartolozzi red, sea green, blue, transparency grey, or, in fact, in any colour. It may be had cut to size, or in bands or rolls, and for my own use I strongly recommend beginners to follow my lead in this matter at least; I prefer that cut to size, as costing less in the end than buying a whole band, though of course when advance has been made, and considerable numbers of prints have to be made, bands will be cheaper.

The sensitising solution is made by dissolving :—

Potassium bichromate	...	...	1 oz.
Distilled water ...	...	...	20 oz.
Liq. ammonia (·880)	...	...	5 drops

The cut tissue may be floated on the surface of this if desired, but personally I prefer immersing the tissue, and therefore I give directions for this.

Take a deep porcelain developing dish, one or two sizes larger than the tissue to be sensitised; fill this to about the depth of an inch with the above solution. Take a piece of tissue with both hands, and immerse one edge first below the liquid, drawing the whole under the surface. Allow to soak for thirty seconds; then, taking hold of the edge first immersed, draw over the edge of the bath and hang up by wooden clips or pins to dry. The temperature of the solution must not exceed 79° Fahr., but in winter the tissue may be allowed to remain for forty-five seconds.

It is possible by altering the method of sensitising to alter to some extent the resulting prints. Thus, by floating the tissue, softer and less vigorous prints may be obtained. If on the other hand the paper support is floated on the liquid, and the solution is absorbed by the lower layer of pigmented gelatine more than the surface, harder and more vigorous prints result; whereas by immersing the tissue uniform sensitiveness is obtained.

Ammonium bichromate may replace the potassium salt, in which case the solution of ammonia may be omitted, but I am not aware that there is any greater sensitiveness thus obtained. After sensitising about a dozen or eighteen cut sheets I always add a little fresh stock solution.

DRYING THE TISSUE.

This operation is an important one, and on the successful performance of it depends to a great extent the success of the subsequent operations, for should the time taken in drying be too long, the tissue will become insoluble or adhere less firmly to its support. The more slowly the tissue is dried within reason the more sensitive it is, but I prefer to keep it a little longer when dry if increased sensitiveness is required. I always use a specially constructed drying-box, but the want of this need not deter any amateur from trying the process. If the tissue is sensitised at night by candle-light and left hanging up, pinned for instance to a domestic clothes-horse, about two yards in front of a fire, it will be dry by the morning, and if the blinds of the room are drawn down, so as to exclude all white light—or yellow blinds may be used—the light will not affect it.

KEEPING THE TISSUE.

When sensitised the tissue will keep in the ordinary way about a fortnight, though it may be kept longer by being placed in a tin box provided with a chloride of calcium drying chamber. The damper the paper the shorter the time it will keep.

PRINTING.

The first essential is to provide the negative to be printed from with what is technically called a "safe-edge"; this is an edging of paper or thin coating of opaque black varnish. The safe edge should not be absolutely opaque, and I always use thin orange yellow paper, or the yellow or pink lantern-slide binding strips may be used with great convenience, and are just about the right width. The paper should be stuck on to the glass, not the film, though if thin paper be used it may be stuck on the film.

Any ordinary printing frame may be used, but I always use the india-rubber pads as used for platinotype printing, which not only ensure better contact between tissue and negative, but keep the former from absorbing moisture.

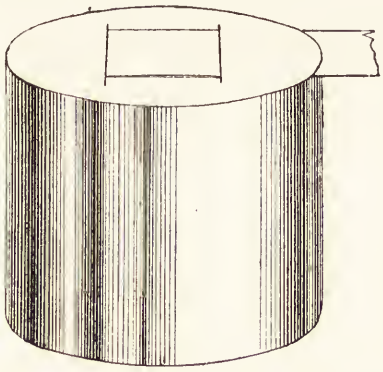
As the progress of printing cannot be observed by looking at the tissue, we have recourse to some contrivance which is called a photometer or actinometer.

THE PHOTOMETER OR ACTIMOMETER.

There are several kinds in the market, such as Woodbury's, Johnson's, etc. Watkins' exposure meter can also be used if desired, or the number tablet of Warnerke's sensitometer I have used at a

pinch, and it is by no means difficult to construct one at a trifling expenditure of time, trouble, and money.

For this purpose procure a one-ounce purple-shouldered pill-box from any chemist, lay the lid of the box upside down on the table, take a sharp penknife and make two half-inch slits in it, parallel to one another and about half an inch apart. Be



careful that there are no ragged edges to the slits, which would cause possibly subsequent trouble. Now take a piece of ordinary sensitised paper, or even gelatino-chloride paper will do, cut it into strips three-eighths of an inch wide, insert one end through one of the slits and into the other, so that when the lid is on the box you have just half an inch of sensitive paper showing. In the side of the lid, just in a line with the two slits, cut a

half-inch slit; through this draw the end of the paper. It will thus be possible to draw out the paper as required.

Now to make the actinometer. Take the above little home-made box—a sketch of which is here given—into the open air, and expose the paper to light till it turns to a fairly strong colour—about the tint of an ordinary silver print when one-third printed. Then retire to your workroom, with water-colour try and match the tint of the paper as nearly as possible, and be careful that it matches it when the water-colour pigment is dry; and then the actinometer is ready for use.

THE ACTUAL PRINTING.

Expose your frame in a bright light—some even recommend sunlight for dense negatives; but it must be, of course, a *sine quâ non* that the tissue is absolutely dry. Should the film of pigmented gelatine retain any moisture, it is of course obvious that it will, when printed in the sun, give rise to trouble.

A printing frame with hinged back, of the ordinary pattern, is not a necessity, as the tissue is not examined during printing. Many of the ordinary printing frame backs are lined with cloth which is very coarse and lumpy, and this may give rise

to uneven contact. For my own work I use a piece of planed mahogany and one or two sheets of white blotting-paper, or the india-rubber pads mentioned above.

The printing frame and the actinometer should be placed side by side when printing, and if much carbon work is done, I should advise the operator to obtain some stout copper wire, bend it round into a circle, and drive the end into the side of the printing frame, so as to form a little holder for the actinometer.

As the exposure is estimated by the depth of tint to which the actinometer paper darkens, it is obvious that a somewhat close watch on the process must be kept. After a little experience, one soon gauges the requisite time or number of tints required to print from a certain class of negative—approximately of course. A rough idea of the duration of printing may possibly be given when it is known that carbon tissue prints in about one-third of the time necessary for silver printing. But the sensitiveness of chloride paper, Ilford P.O.P., is about the same as carbon tissue. Where large negatives have to be printed from it is just as well to expose a small piece of tissue under a typical part of the negative.

When printing has continued for some time and the actinometer has registered one tint, then the

sensitive paper is drawn forward to expose a fresh piece. Of course with actinometers with numbered squares it is only necessary to note the numbers.

It is always advisable to print several pieces of tissue, although, there being no toning bath, it is not a question of cost, but one of trouble, as hot water is used, and it as easy to develop six or twelve prints as one.

DEVELOPMENT.

Somewhat analogous to the gelatino-bromide dry plate, the image is invisible as a rule, although on some of the lighter-coloured tissues it is possible to see the image faintly. There are advantages over dry-plate developing: in the first place, we can work by ordinary candle or gaslight, or even faint daylight; but probably the carbon worker will prefer to utilise every available hour of printing light, and can thus get a dozen or more prints off and develop the whole in the evening. Hot water is the only developer, so that we have no finger stains, and practically not such nicety as to the exact composition of the developer.

The requisites for developing are:—

4 Dishes	1 Sheet of Zinc
1 Squeegee	Single-Transfer Paper

Hot Water

Like the Irishman, we begin with the last thing first. Hot water may usually be had in households; but it is not always convenient to have to trot down from the dark room to the kitchen. To avoid this trouble and always have some handy, I use one of the copper kettles provided with a spirit-lamp underneath which are so much the fashion just now for tea-tables; and having got a good supply of hot water in my dish and the kettle filled with hot water and the spirit-jet alight, there is no further trouble.

The dishes may be porcelain, zinc, or enamelled iron; it is not advisable to use ebonite or glass, for fear of warping or cracking them. Always choose your dishes a decent size and a good depth. For half-plates I use a small lead sink, which measures 11 × 13 × 6 ins., and whole-plates can easily be developed in this. Plenty of room and plenty of water will not come amiss.

The squeegee should be one of the scraper kind, not a roller. My attempts with these last have not been happy; somehow I have always got air bubbles. It may be my fault—possibly it is; still I prefer scraper squeegees.

A sheet of zinc is advisable, though old negative glasses may be used. The zinc I use is No. 18 gauge, costing 1s. 8d. per square foot, and for half-plates measures 10 in. square, and can be used for

whole-plates and half-plates; costing so little, it need not be spared.

Single-Transfer Paper.—This is paper coated on one surface with insoluble gelatine, and may be obtained commercially. Failing this, one may use baryta paper, such as used as a support for gelatino-chloride printing-out emulsions, and this may be obtained either white or tinted. W. K. Burton, in his work from which I have previously quoted, says: "It may be useful to know that common albumenised paper may be used in place of either single-transfer paper or the final support used in the double-transfer process. In all the older carbon processes some cement was used to fix the gelatine image to the support, and amongst them was albumen. Common albumenised paper contains salt, as the reader well knows, but this has no bad action on the carbon film. In using the albumenised paper the operations are exactly the same as in using single-transfer paper, only that the albumenised paper must be soaked in water no longer than is necessary to soften it; otherwise the albumen will be dissolved away, and will not, of course, act as a cement. The albumen in the high lights is sure to be dissolved away during the development, with the result that a fine matt surface is got. In spite of the matt surface, the writer considers that almost better results are got in the case of small

work with the ordinary albumenised papers in the market than with the papers specially coated for single and double transfer, and the thin albumenised paper is certainly particularly well suited to the production—to be described hereafter—of the particular kind of print known as 'Lambert-type.' The use of common albumenised paper in the way just mentioned was first described to me by my friend K. Ogawa."

Having everything ready, place your dishes in line. The first fill with cold water, the second with hot water at a temperature of 100° to 110° Fahr.; at first it is advisable to use a thermometer, but after a little practice one soon knows the right temperature from the feel. The third is used for cold water, and the fourth is reserved for the "fixing" solution—not our old friend "hypo.," merely a saturated solution of common alum in water. Put a sheet of single-transfer paper—which should be cut a little larger than the print to be developed—in the first dish, and allow it to remain for three minutes or till it feels slimy. Now immerse a piece of exposed tissue face downwards and allow it to soak. This will at first curl up, or if very dry even roll up, film inside; it will soon begin to straighten, and, if left long enough, curl up the other way. But as soon as it is all but flat bring the transfer paper and the tissue into contact; have the zinc

plate ready, slip under, and raise the whole from the dish, carefully adjusting the exposed tissue into the middle of the paper ; then apply the squeegee vigorously—do not be afraid, absolute contact is a necessity, and no harm can be done except rubbing up a little of the paper. Use the squeegee from the middle outwards in all directions, and then up and down and across the print. Lift from the zinc plate on to two or three sheets of white blotting-paper, place the same number on top, and then a heavy weight.

Should only one or two prints have to be developed they must be left for twenty minutes, or even longer if absolutely necessary ; where several prints have to be developed they should be treated in the same way, and placed on the top of the first, and then after the lapse of twenty minutes from squeegeeing down the first print the pile may be turned upside down and the first print is ready for development.

Taking the first print on its "single-transfer" paper support it is *immersed* in the hot water, and allowed to remain for a few seconds, when it will be seen that the pigmented gelatine will begin to ooze out from the edges. Now take hold of a corner of the original paper support, and gently and carefully pull it off. If it comes off easily, well and good ; if not allow it to soak for a few seconds

longer, and commence at another corner. When completely removed, this paper may be thrown away, as, having served its purpose, it is no longer of any use.

The print at this stage will probably look a dirty, smudgy mess, and with the darker tissues be quite buried in the melting tissue. Now form a cup of the palm of your hand, and dash the hot water on to it. As this is effected, the image becomes clearer and clearer, the pigmented gelatine not acted on by light being washed away by the hot water. In about four or five minutes the process of development will be complete. Development should not be hurried, it being far preferable to use cooler water and take longer, as it is possible thus to compensate more readily for errors in exposure, a subject I shall treat of in Failures (*q.v.*).

As carbon prints always dry a little darker than when wet, development should be pushed just a shade further than when the finished print is required. A little experience soon teaches one how far to go. As soon as developed, put the print into the third dish of cold water; this chills the gelatine, and may be said to perform a sort of provisory fixing.

FIXING.

Our print is not yet complete; it still contains, both in the paper and in the film, some soluble bichromate, and the object of "fixing" in the alum bath is the removal of this. After a few minutes' stay in the third dish of cold water, the print should be placed in the alum bath till absolutely free from any yellow tinge, and then washed to remove the alum, and dried when the print is complete. The alum also hardens the film, and this, together with the hardening action of light and the permanent character of the pigments used in the carbon process, has caused it to be considered the acme of photographic printing as regards permanency.

THE DOUBLE-TRANSFER PROCESS.

Probably some of my readers will not quite understand what this is, and I must try and put this as clearly as I can. If we print from a negative by contact on any paper—or, to make it easier, let us say a lantern slide—and when our slide is dry we hold it up with the film towards us, we see a correct representation of what we saw in the view or subject which was impressed on the negative. But if we turn the lantern slide round so that the glass is next us, we find that things which were

previously on the right have now come on the left, and this is precisely what happens in the carbon process.

We print by contact from a negative, and then turn our tissue round and develop from the back, so that the left becomes right and right left, and as the left is not the right it isn't right, although in some cases we need not trouble our heads about that. For instance, in printing from a bust or quarter-length portrait, it does not much matter whether the portrait of a pretty young lady be turned round so as to make her left ear the right and *vice versâ*—probably she will be quite as pretty one way as the other; but should that young lady's left hand be included, and the third finger of that hand bear a wedding ring, it will look curious to see her in the print with a wedding ring on her right hand.

In landscape work this "lateral" reversal may often be neglected when *picture-making* pure and simple, as opposed to topographical studies of places we know, is the object.

To get us out of this difficulty, therefore, we have recourse to the double-transfer process, which consists in squeegeeing the print down to a waxed support, flexible or otherwise, and then applying the final support, and when dry stripping. This is not a difficult process, and, reverting to our lantern-

slide simile, means that we have simply turned the slide round again, so that the film is next us. To transfer our print then, or put right, we use a

TEMPORARY SUPPORT,

which may be either flexible or rigid, polished or matt, according to the surface desired in the final print. Should a matt surface be desired, "smoothed" opal may be used; smoothed opal is opal which is finely ground on one side, and is probably called "smoothed" on the *lucus a non lucendo* principle. Personally I much prefer zinc, and using the same gauge, No. 18, as previously mentioned, it can be mulled or grained by using fine emery flour and water, or a weak nitric acid bath.

Flexible supports are to be obtained commercially, and are really paper coated with insoluble gelatine and solution of shellac, so that it is impervious to water. Flexible supports are somewhat easier for beginners to manipulate, but it is not possible to matt surfaces with them.

Whatever the temporary support be, it must before use be waxed, in order to facilitate stripping. The solution recommended for this purpose is :—

Yellow resin	...	...	...	36 grs.
Yellow wax	...	...	...	12 „
Turpentine	...	...	...	2 oz.

Melt the wax, add the resin, stir for a little time, remove from the fire, and add the turpentine. I have suggested elsewhere the substitution of ether for the turpentine in the above formula, because the ether evaporates more quickly, and the transfer paper or temporary support may be used more quickly. I must confess that I was under the impression this was quite original, but I find that ether was used instead of turpentine quite in the early days.

The temporary support is zinc or paper waxed by means of the above solution, a little being poured on to the middle and smeared all over with a little pad of lint, wash-leather, or soft linen, and then polished with another piece. When the turpentine formula is used, the support must be left some hours before use, to allow the turpentine to evaporate. Having our temporary support ready, we need only prepare our

FINAL SUPPORT

to have a finished print.

Final supports may be glass, leather, wood, metal, stone, opal, or paper, but we shall content ourselves first by describing the use of paper. Paper specially prepared may be obtained commercially, and is now

ordinary paper coated with a film of gelatine. This has to be soaked in 2 per. solution of alum for about ten minutes, and it is ready for use. The operations for double-transfer prints are practically the same as for single-transfer so far as regards development, but for the sake of beginners I run through the whole process again.

Expose your tissue in a frame simultaneously with the actinometer; when sufficiently exposed lay the tissue in water till soft, place the previously waxed temporary support in the water, bring the tissue into contact, squeegee well, and develop as previously described. When developed, dip in cold water, transfer to alum bath, wash well, and bring the final paper support, which has been soaking in alum, into contact with the developed print, squeegee well, and allow to dry. When dry, the print and its final support may be stripped by inserting a knife under one corner, and gently pulling.

RIGID FINAL SUPPORTS.

In all cases where a rigid final support is desired, it is essential to use a flexible temporary support; otherwise intimate optical contact cannot be obtained. In every case the procedure is precisely the same so far as development, washing, and fixing are

concerned, a slight difference only being necessary in the preparation of the final support.

TRANSFERRING PRINTS TO OPAL.

Carbon prints on opal, particularly the smoothed or matt surface with bevel edges, form exquisite ornaments for any room, as they can be prepared in any colour and mounted in any style, either on plush mounts or as transparencies, etc., and of any shape ; and I have some charming little candle shades prepared by the carbon process on circular opal plates.

Matt opal requires no preparation, the carbon image holding firmly enough ; the image on the temporary support being merely squeegeed well to the opal, set up to dry, and the temporary support stripped.

TRANSFERRING PRINTS TO GLASS, METAL, WOOD, IVORY, OR ANY POLISHED SURFACE.

The only difference in this is to prepare the surface of the final support, and this may be done in two ways, either by giving it a coating of

bichromated gelatine or with chrome-gelatine; personally I prefer the latter. I give both methods, however.

THE BICHROMATE METHOD.

Heinrich's gelatine	1 oz.
Distilled water	18 „

Soak for four hours; dissolve by the aid of a water bath.

Potassium bichromate	20 grs.
Distilled water	2 oz.

Dissolve and add to the gelatine solution; filter whilst hot, and coat the support with as thin a film as possible; dry and expose to sunlight for an hour at least, or diffused light for four hours.

THE CHROME-GELATINE METHOD.

Heinrich's gelatine	320 grs.
Distilled water	20 oz.

Soak for four hours; dissolve by the aid of heat or water bath.

Chrome alum	12 grs.
Distilled water	4 oz.

Dissolve, add to the gelatine, and filter. Coat the glass or final support as thinly as possible.

When using wood, leather, or any porous support it is advisable to fill the pores as much as possible, and for wood I always use Aspinall's enamel thinned down with turpentine and rubbed in with a pad.

The average worker of ordinary ingenuity will have no difficulty in adapting from these hints the process to any surface. Of the two substrata given, the chrome gelatine is superior, but unless care is exercised in mixing there is a great tendency for the gelatine to precipitate.

LANTERN SLIDES.

Probably of all processes for lantern-slide making the carbon process is that which gives the very finest results—exquisite gradation, transparency in the shadows, and, when required, bare glass. It is not more difficult than other processes for the production of lantern slides—perhaps not so difficult—and the single-transfer process may be used, as a reversed slide is of no consequence, and may be put right in mounting and marking.

The ordinary tissue may be used and will not give good results; the finest results only are to be obtained with the special transparency tissue, which contains an extra amount of pigment and of a finer kind. This should be bought from the

manufacturers and sensitised on the ordinary bath. For lantern work it is advisable to get tissue cut to a convenient size, such as $6\frac{1}{2} \times 6\frac{1}{2}$ ins., which obviously cuts into four lantern slides of $3\frac{1}{4}$ ins. square. Obtain some patent plate glass—this can be bought very cheaply at any plate-glass insurance office—a little larger than the tissue, about half an inch each way, coat it with a plain collodion, such as

Pyroxyline	$6\frac{1}{2}$ grs.
Ether	$\frac{1}{2}$ oz.
Alcohol	$\frac{1}{2}$ „

Coat the glass with this collodion after having waxed or talced it, and, as soon as the collodion has set, transfer to a dish of cold water. When the tissue has floated long enough on the sensitising solution, slip the collodionised glass underneath, remove both together, squeegee, and set up in the dark to dry. When thoroughly dry, strip from the glass, cut up carefully into squares of the requisite size, and expose under a negative in the ordinary way, as previously described, using as a safe-edge a lantern mask or the black varnish previously described. The exposure is about half as long again as for ordinary carbon work.

To prepare the glasses, they should be coated with the chrome-gelatine described on p. 58, or may be treated with

White wax	...	...	...	12 grs.
Benzine	...	...	...	2 ozs.

which is used as previously described for waxing the temporary support, or the glass may be coated with albumen, which is prepared as follows :—

Dried albumen	...	...	...	20 grs.
Distilled water	...	...	...	20 oz.
Liquor ammonia (·880)	...	...		2 mins.

Dried albumen may be obtained from the leading photographic dealers. The albumen is added to the water, and gently heated in a water bath to 120° Fahr.—not above, and then the ammonia added and the whole filtered. The glass is coated with this as when collodionising, and allowed to drain and dry in a place absolutely free from dust.

The exposed tissue is soaked in water, squeegeed to the glass, and developed, fixed and washed in the ordinary way, and when dry our slide is ready and only needs binding and marking to be complete for exhibition. As the slide is reversed, the usual spots which mark the side to be placed next the condenser must be placed on *the face of the slide-glass itself*, and not on the cover-glass, as is usually done.

Burton suggests an alternative method of collodionising the tissue, which is merely turning up

the edges of the exposed tissue so as to form a little dish, and coating it then (*i.e.*, after exposure) with collodion. The subsequent operations are precisely the same as above.

FAILURES.

The carbon process, like every other photographic process, is not free from possible failures ; they are not, however, insurmountable. I shall treat of them in the order of procedure to facilitate matters.

The tissue is insoluble.—This may be caused by (*a*) acid bichromate of potash—hence the suggestion to add a little ammonia to the sensitising bath ; (*b*) too slow drying or a damp drying room ; (*c*) gaseous products of combustion in the drying room ; (*d*) keeping the film too long ; (*e*) keeping in a damp place ; (*f*) exposure to light ; (*g*) unsuitable gelatine or too little sugar in the plain jelly.

The film dissolves in the sensitising bath.—The bichromate solution is too warm ; cooling by adding ice will prevent this.

The gelatine runs while drying.—Drying room or box is too warm.

The tissue, when dry, refuses to lie flat on the negative.—The paper was dried too quickly, or at too high a temperature.

The paper sticks to the negative.—The tissue, the negative, or printing frame pads are damp. Remedy, rub the negative and tissue with talc.

Crystals form on the tissue in drying.—Too strong a sensitising bath.

The film frills.—The causes may be (*a*) insolubility of the film ; (*b*) absence of the safe-edge, or putting the safe-edge on the film and not on the glass side of the negative ; (*c*) allowing the tissue to soak too long in the cold water before squeegeeing to the temporary or final support ; (*d*) too short a time between squeegeeing to the support and developing ; (*e*) when developing tissue on a collodionised glass, frilling occurs when the collodion is torn or scratched so that water can get underneath.

Reticulation of the film.—This may be said to be incipient frilling, and the same causes may be assumed, with also the additional one (*a*) using the temporary support too soon after waxing, or (*b*) too freshly sensitised tissue.

Spots and streaks in the finished prints.—These may be caused by (*a*) unequal coating of the tissue, (*b*) air bubbles on the sensitising bath, or (*c*) solid impurities in the bath ; (*d*) air bubbles between the temporary support and tissue—to remedy this it is just as well to pass the squeegee over the tissue under water just before applying to the support.

The prints are too dark.—(*a*) Over-exposure, (*b*) keeping the tissue too long between exposure and development in a damp atmosphere. The cause (*b*) is due to what has been called the continuing or continuating action of light, and this only occurs in a damp atmosphere. Carbon tissue, when exposed, will keep for a long time in a chloride of calcium tube. This continuing action of light has been suggested as useful in the case of under-exposed tissue, as by leaving it a little time in the dark want of sufficient insolation may be compensated for.

Over-exposure is in effect, of course, the same as over-printing with ordinary silver paper. It may be remedied to some extent by using hotter water. Some operators have recommended soapy water, but this I have never tried. Swan suggested chloride of lime, hypochlorite of soda, chlorine water, and peroxide of hydrogen; but of all remedies, hot water continually applied is the best. A very large firm of carbon printers have an arrangement which struck me as very practical, and which I saw made useful for forcing over-exposed prints. Hot and cold water was laid on, as is now so often the case in modern-built houses, and to the respective taps was affixed a short length of inch-diameter india-rubber pipe. This in the case of over-exposure is compressed at the end, and the

tap turned on, and a fine jet of hot water is thus directed on to the print. The same device is used with the cold water, and, whilst there, the operator kindly showed how easy it was to alter the character of the prints by using one or the other spray in this way. Sulphocyanide of ammonium has been used for lightening over-exposed carbon prints, but so far my experiments have been merely to prove that quite as much may be judiciously done with hot water as with a weak solution of sulpho.—whereas, if a strong solution be used, even cold, it is impossible to regulate its action.

The prints are too light.—Under-exposure will cause prints to be too light, though it may happen that with negatives which are harsh and full of contrast the details in the high lights may wash away, whilst the shadows are too dark. To avoid this it may be advisable to expose the tissue to diffused light for a short time, so as to sun down as in ordinary silver printing; this will of course soften the results by preventing the high lights from washing away and by a general tint lowering the tone.

It is possible to intensify prints by soaking for a few minutes in

Nitrate of silver	2 grs.
Distilled water	1 oz.

Rinse under the tap, and flood with

Pyrogallic acid	... 1 gr.
Citric acid	... 1 „
Water	... 1 oz.

to which is added at the moment of using two or three drops of a 20 per cent solution of nitrate of silver. After intensification, the print should be dipped in hypo. and well washed. It may also be dipped into a 1 per cent. solution of perchloride of iron, well washed, and then into a weak pyro. solution (1 gr. to 1 oz. water). The best intensifier is to dip the prints into a 20-gr. solution of permanganate of potash in 1 oz. of distilled water, wash well and dry, repeating if necessary. During development, the use of cooler water will of course compensate to some extent for under-exposure, by not washing away so much of the pigmented gelatine.

A sparkling appearance in the print after final transfer.—This is caused by too little pressure during the final transfer.

Prints developed on collodionised glass refuse to leave the glass.—The fault lies in not waxing the glass properly, or else polishing off too much wax.

RETOUCHING, SPOTTING, AND COLOURING CARBON PRINTS.

Carbon prints may be spotted out without any trouble. A little solution of chrome or bichromated

gelatine, such as used for a substratum for lantern slides, etc., should be mixed with the requisite colour and applied with a fine brush. If the retouching be done before the final transfer of the print, it will be under the gelatine film, and thus show less than if done after.

Colouring carbon prints with water-colours is extremely easy, especially if a little semi-aqueous and alcoholic solution of purified inspissated ox-gall or Newman's sizing preparation be brushed over it first. To colour with oil-colours the best thing is to apply with a broad, flat camel's-hair brush a solution of

Isinglass	... 180 grs.
Distilled water	... 10 oz.
Methylated spirit	... 10 „

Allow the isinglass to soak for two hours in the water, dissolve in a water bath, and then add the alcohol with careful stirring.

ROUGH PAPER SUPPORTS.

The use of rough paper as a support for carbon prints has grown considerably in favour, and therefore the following brief note is added.

The rough paper, Creswick, Whatman, or other kind should be pinned on to a drawing board, and a fairly large pool of the chrome gelatine poured

on to it, and evenly distributed with a fairly stiff hog-hair brush; the solution being worked into the paper, it should be then allowed to set and thoroughly dry. This can be then used as the final support, but in transferring the carbon image to it, the two must be put under a very heavy weight, so as to ensure complete contact.

MATT-SURFACE PRINTS.

An exquisite fine matt surface, may be obtained by coating "smoothed" opal with plain enamel collodion, allowing to set, washing out the solvents, or till the surface is no longer greasy, and then transferring the print to this as a temporary support.

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Besides the above most textbooks contain more or less full instructions for working the process.

Considering the very brief time that has elapsed since this little work was written, there is not much of any great importance to add to this, the Second Edition. The most striking point is the use and preparation of the so-called Ladeveze and Artigue's processes of carbon printing, in which no transfer

is necessary, the print being developed from the front by a mixture of water and fine sawdust ; and a note upon Bedford's insoluble substratum.

ARTIGUE'S PROCESS

Although not strictly new, having been actually made since 1884, this paper, Artigue papier velours, has only lately sprung into prominence, at least in England ; and it is interesting in that no transfer is required, the print being developed from the front, after printing in the usual way, with sawdust and water.

Whilst no exact formulæ are to be found for making this paper, sufficient has been published to allow any one, with but little practice, to secure satisfactory results.

Smooth rives paper is damped and squeegeed to a sheet of plate glass, and then coated as evenly as possible with a 1·5 per cent. solution of soft gelatine ; or damp rives paper may be allowed to float on a 4 per cent. solution of gelatine at 30° C. This is allowed to set, and placed in a dusting box, such as used for photogravure, in which is the powdered pigment in a fine state of division. The box is slowly revolved, the sides being knocked to dislodge adhering lumps ; and after about five or six revolutions the box is brought to rest, and

allowed to stand for about two minutes; and then the glass plate with the damp paper is inserted, and the powder allowed to settle for about five minutes. The glass is then removed, and the paper examined to see whether it is sufficiently coated. The whole of the surface should be a uniform colour, showing no sign of white. If necessary, the operation is repeated, and when sufficiently covered the paper is allowed to dry thoroughly. In this state it will keep indefinitely. An alternate plan which suggests itself, but which I have not tried, is to coat the paper with gelatine, and when set, blow the powder on by means of one of the insufflators used for nasal diseases.

To sensitise this paper, it should be floated on the back, not film side down, on a 5 per cent. solution of bichromate, care being taken not to allow any of the solution to get on the coated side. It is then removed, and pinned by means of drawing pins to a wooden frame or stretcher, so that the film side is underneath, but also so that there is free access of air. Instead of floating, the bichromate solution may be applied with a broad brush to the back; but this is less convenient, as the paper must be strained whilst this is being done.

The paper is printed the same as usual with a photometer or actinometer, the rapidity of the paper being stated to be about three times that of silver

paper. It is then pinned to a flat strip of wood, or held between two thin laths clipped together by wooden clips, and developed by pouring on to the surface a thick mixture of warm water, about 90° Fahr., and very fine sawdust, fir or boxwood being the best. The sawdust should be placed in any convenient vessel, an ordinary tin coffee-pot, with rather small spout, being very handy. As the warm sawdust mixture flows over the surface it abrades the particles of gelatine and colouring matter which have not been rendered insoluble by the action of light ; and as soon as the picture appears in all its details it should be well washed with a spray of cold water, which arrests the developing action, and washes away any adherent sawdust. If the exposure was not undertimed, and development not carried too far, the resulting print will possess fine gradations of half tone and full detail.

The hotter and thicker the sawdust mixture, the greater the developing action ; and it is frequently advisable to commence development with a thin mixture of about 75° Fahr., and then to use a thicker and hotter mixture subsequently. It is obvious that in the local application of sawdust mixtures of various strengths and temperatures considerable command over results can be obtained.

The finished print is washed in alum solution

and cold water, as for the ordinary carbon process, and dried. The prints have a fine matt surface, and for some subjects the results are extremely fine.

From the preceding description it is obvious that this process is applicable to almost any surface, such as glass, plain or opal, ivory, wood, leather, or even fabrics.

M. Artigue's paper is sold commercially in France, but there seems considerable difficulty in obtaining a supply, therefore for those who like to make it themselves, the above directions will possibly suffice.

Practically the above and the following process, that of M. Ladeveze, is nothing more than a revival of the earlier processes, particularly that of Pouncy, described in the commencement of this work.

Instead of gelatine, gum arabic is used as the colloid, and the following method of procedure will be found quite satisfactory :—

Choose clean and fairly white gum-arabic, free from dirt ; place the required quantity in a cup or jam pot—the latter is the better—capable of holding at least four times the quantity of water. Thus if 4 ozs. of gum be used the vessel must hold 16 ozs. of water. The gum should be placed in the vessel, and the same filled with water, stirred rapidly once or twice, and the water poured off. This operation should be repeated, the object being to wash away mechanical impurities ; then the

proper quantity of distilled water should be added to the washed gum, and the vessel placed in a warm place, and frequently stirred, till the whole is thoroughly dissolved. Some fine meshed muslin should be well washed in warm water to free it from dressing, and then tied over the mouth of the jam pot, and the solution of gum strained through it.

The correct strength for the gum solution is :—

Gum-arabic	...	...	4 ozs.
Distilled water	...	...	8 ozs.

After solution and treatment mix in equal volumes with a solution of

Potassium bichromate	...	...	1 oz.
Distilled water	...	...	10 ozs.

Stir the mixture thoroughly, and then add the colouring matter, which may be any of those described on pp. 34 and 35. The pigmented colloidal mixture is now applied to the paper by means of a soft badger hair softener ; and this should be worked over the surface of the paper, till on holding it up to the light it appears of a uniform tint all over. The pigmented colloid matter may also be applied to the paper by means of an ether throat spray apparatus, and very fine even coating is thus obtained.

So far the whole of the operations may be con-

ducted in diffused daylight, but the paper must, as in the case of ordinary carbon tissue, be dried in the dark. Development may be effected by placing the paper in a dish of tepid water, and gently rocking. Or this print may be pinned to a board, or clipped by the edges to a sheet of glass, and developed by the aid of a soft brush, or by using the spray apparatus. In this way very great control over results is attainable.

CARBON PRINTS ON TONED PAPERS.

Mr. G. H. James has suggested the use of toned papers as a support for carbon prints (*Amateur Photographer*, January 4th, 1895). He says :—

"Photographers have, up to the present time, but accepted and shown one form of support for their pictures—namely, a colour white. They have taught their audiences that that, and that only, is possible. We now ask them to teach something else; we ask them to teach the public that the lights and shadows in a picture depend upon each other, that they work by contrast, and that they do not depend on white paper for the highest light, and black pigment for the darkest shadow."

Mr. James goes on to recommend brown papers of various tints, and thus describes one of the many cases for which such toned supports are suitable :—

"I passed over one of the many bridges which span our London river as it winds through the great city, one evening, a while back, and a most pathetic scene caused me to stay a moment. The noisy traffic had passed on its way, and all was quiet, save for the murmur of the waters, which rolled, and turned, and eddied against their granite walls, passing away, as it seemed, right under my feet. The sun had set some short time, and threw up, from below the horizon, that beautiful 'after glow' of golden-red, fading into yellow as it mounts high overhead.

"The mist rose slowly from the shadowed river, and met that beautiful smoke cloud (of all clouds the most pathetic), throwing the distance into a dim nothingness. A solitary barge, with its bargee, floated slowly down with the stream; and as he dipped his oar to guide his unwieldy craft, the rippling waters caught little beams of yellow light from the sky above, as if to add a spark of brightness to the quieting scene. The barge passed on, and the evening faded into night, and I was the gainer over the world for having seen a picture which perchance they did not miss.

"It is pictures such as these—impossibilities to us with ordinary means—I try to adequately represent with my peculiarly coloured papers."

Whilst of course it is possible to transfer ordi-

nary carbon tissue to toned papers, there must be infinitely greater command over results by using one of the above processes, Artigue's or Ladeveze's, as the choice of pigment is entirely in the operator's hands.

BEDFORD'S INSOLUBLE SUBSTRATUM.

The late Mr. William Bedford, well known as a worker of no mean ability, suggested the following method of preparing an insoluble substratum for the preparation of glass plates, to which the carbon image is to be transferred :—

Take of hard gelatine 270 grs., and soak for an hour in 3½ ozs. of water, and melt by the aid of a water bath. To this solution add sufficient 5 per cent. chrome alum solution to thoroughly precipitate the gelatine, which should then be collected, and the water allowed to drain, and then dissolve in 7 drms. of glacial acetic acid on a water bath, and add gradually 17 ozs. of methylated spirit, and filter for use. The glass should be well cleaned, and the solution of gelatine poured on just like collodion, and the plate set up to dry.

HISTORICAL AND PRACTICAL NOTES ON THE SIMPLE CARBON PROCESS WITHOUT TRANSFER.

Reprinted from THE AMATEUR PHOTOGRAPHER *of March 6th and 20th*, 1896.

The following chapter will give a general idea of the field covered by the Non-Transfer Carbon Process; but the reader intending to take up this method is referred to the book entitled, "Aquatint, or Gum-Bichromate Process," by Messrs. Alfred Maskell and Robert Demarchy, now in the press.

That the simple non-transfer carbon process will give, not only the most perfect gradation of tone, but the most minute definition even for small subjects, has been fully recognised by experts for at least thirty-eight years, in evidence of which we may quote the following, written in 1858, by no less an authority than Thomas Sutton. Speaking of the method originally due to Poitevin, but independently discovered and introduced by Mr. Thomas Pouncy, of Dorchester, Mr. Sutton writes (Sutton's "Notes," 1858, p. 185): "It will give and does give as good definition and half-tone as any other process upon plain paper, and it will prove to be the very thing most ardently wanted by sensible photographers, and when fairly brought into operation it will supersede all other modes of printing." In the first issue of Mr. Sutton's

"Notes" for the following year (1859, vol. iv., p. 7), we find very concise directions for working the method which scarcely differ from those given in this chapter ; only the convenience of development by cold water is more emphasised in these directions than in ours. The following are particulars as given by Pouncy in 1859, but with such slight curtailment in descriptive detail as the general knowledge of our time renders admissible :

1. Saturated solution bichromate of potassium.
2. Gum of consistency of thin varnish.
3. Vegetable carbon ground with water, by muller on paint stone. (Mr. Pouncy appears to have intended this to be quite fluid and even thin.)

Mix together equal parts of 1 and 2, also sufficient quantity, say, one-eighth the total volume, of No. 3. Stir and strain through finest muslin. Coat paper freely with a broad camel's-hair brush, laying on a copious supply over the whole surface ; allow about two minutes for the paper to absorb, and remove the superfluous liquid thus ; take a painter's four-inch hog's-hair softener, and work it regularly over the paper, with an alternate vertical and horizontal motion, until the whole presents a smooth and even surface. The drying may be completed by the fire. The directions for exposure need not be reproduced, but Mr. Pouncy's instructions for development with cold water we give

verbatim: "On removal from the pressure frame, lay the picture, face downwards, in a flat dish of clean water, taking care to exclude all air-bubbles. It will be found advisable to place some slight weight upon the picture, that the back may thus be retained wholly under water and kept free from stains. The time of soaking may be roughly stated at five minutes; though in some cases of over-exposure pictures may remain in the water for days, and come out equally good. It may be observed here, that when the high lights of the picture appear soon after immersion, the operator may conclude that he has *under-exposed*, or that his gum-arabic is *too thick;* which last fault must be corrected by the addition of a little more bichromate solution. It is preferable to find the picture developing evenly all over. Each picture must be set in a separate dish, and finally washed under a gentle stream of clean water from a tap or a lip cup. Should the margin be not quite clean, pass a camel's-hair brush carefully over it, and, if needful, over any parts of the picture, before rinsing at the tap; but the best results are obtained by soaking only."

* * * * *

Whilst recently Mr. Alfred Maskell has worthily drawn attention to this exquisite process, valuable alike for its results as for its adaptability to the

picture-maker's purposes, we feel that there is room for more precise and explicit details of precedure than have been hitherto given, and with this view the present chapter is written.

The directions, moreover, include the older and newer modifications, and such information as shall enable workers to select which may be best adapted to their special requirements.

It should be borne in mind, however, that, as in other processes greater rapidity is often only attained with compromise of some sort, so in the present process those who seek greater sensitiveness by the use of acid or by use of old solution, must be prepared for occasional failure due to insolubility.

The new carbon process without transfer is perhaps the easiest and least expensive of all printing methods for an amateur, and offers especial attractions to those who aim to bring the resultant image more directly under control, as is so desirable and essential in the higher applications of photography to artistic ends. Not only does the material which forms the base lie open to choice by the worker, instead of being what the manufacturer prefers to use, but the pigment itself is a matter of equally free choice; indeed, various pigments may be mixed so as to give any tint desired, and local variations in tone may be realised quite easily

by those who wish so to do. In addition, the new carbon process lends itself in an exceptional manner to local treatment in development.

The new carbon process is not a carbon process, excepting so far as it is a near equivalent of what is popularly and generally known as the carbon process, and carbon—the most permanent of pigments—may be used should the worker desire to use it. Neither is the new process "new" in any other sense than that it has been recently brought into prominent notice.

M. Rouillé-Ladevèze, to whom is due much of the credit of bringing the method into general use by the issue of his little book,* published two years ago, thus deals with the question of novelty :

"Is the process new?" asks M. Rouillé-Ladevèze. "No," he answers, "for it is the gum, bichromate, and pigment method of Poitevin, and dates from the first photographic period."

Several early workers practised the carbon process without transfer, and among these may be mentioned Mr. J. C. Burnett, Mr. Thomas Sutton, and Mr. John Pouncy, these gentlemen having worked chiefly between 1855 and 1860. The old notion was that an ideal gradation or half-tone must be a smooth, structureless tint, such as was given by

* "Sépia-Photo et Sanguine-Photo," par A. Rouillé-Ladevèze. Paris, 1894, Gauthier-Villars et Fils.

the transfer carbon process of Swan (1864) and its simplification by Johnson (1869); hence these methods soon drove out of use the easier non-transfer methods in which the sensitive pigment mixture is simply spread upon that paper which is to be the final support of the picture. Indeed, the earlier writers scarcely admitted that a gradation of tone in stipple deserved the name of half-tone, hence the contention that in the carbon process half-tone can only be obtained by the process of detaching the film from the unexposed surface.

The method of simple carbon printing, as now practised, may be summarised as follows:—The ground pigments, as sold in tubes or pans for the use of water-colour painters, are mixed with a mucilage of gum-arabic and a certain proportion of a soluble bichromate. This mixture, which must be quite thin and almost like an artist's wash, is now spread uniformly over the sheet of paper with a very large and soft brush; but the coating must not be nearly so dense as to prevent all light from reaching the fibre of the paper. The paper being dry, is exposed under a negative, and then no further treatment is required but development in water, which water should ordinarily be somewhat warm, and occasionally quite hot. When, however, exposure at the back, or through the paper, is adopted, as recommended by Mr. J. C. Burnett

in the "Journal of the Photographic Society," November, 1858, a thicker film of the sensitive mixture should be used, and if a thin hard and smooth paper is employed an even gradation of tint practically without grain may be obtained. Thus the two non-transfer carbon processes can give the widest variation in style or manner. This chapter refers only to that method in which the coated side of the paper is exposed.

The working details are by no means difficult to master, and by no means burdened with exact rules or recondite technical conditions; but there are a few technical points which must be carefully attended to if failure and trouble from the varying sensitiveness and untoward insolubility of the film are to be avoided.

When the exposure is to be made from the front a rough-surfaced paper should be used, as the rendering of full gradations depends essentially upon the roughness of the paper. The various drawing papers give a wide choice, and the choice may be quite free between thick and thin paper. The various Dutch hand-made papers of Van Gelder are excellent as regards chemical purity, and afford a wide choice of texture. Moreover, the prices are very low, as compared with high-class drawing papers. The wholesale London agents are Messrs. Grosvenor, Chater, & Co., of 68, Cannon Street,

who issue a specimen book. The kinds most desirable are Nos. 51, 52, and 83, brown tint, heavy, soft, and coarse grained; also Nos. 1 and 12, white and coarse in texture.

The sensitive preparation is made as follows :—

A.

Clear white gum	4 oz.
Water	6 „

Soak till dissolved, and squeeze through fine muslin.

B.

Bichromate of potassium	1 oz.
Water	9 „

In a room illuminated by yellow light, mix equal volumes of A and B, then stir in such moist water-colours as will give the required tint. The colouration should ordinarily be such that when the preparation is washed over the paper with a broad camel's-hair brush the tint hardly appears full; in other words, the white and texture of the paper should show through. For a very rough paper less pigment will be required than for a less rough paper.

There is a wide choice of pigments open to users of this process, but indigo is best avoided, as it considerably lessens the sensitiveness of the mixture, and ultramarine is not allowable for chemical reasons; but Prussian blue and cobalt remain available among the blues. Indian ink or lamp-black

alone tend towards a greenish tint ; which can, however, be modified by the addition of cobalt blue. Sepia, the earth colours, and the madder lakes are all very suitable.

The paper having been sponged on both sides to stretch it, is pinned down to a board by one corner and rapidly brushed over with the sensitive mixture by means of a broad camel's-hair brush. The mixture should be in a flat dish close at hand, and before the brush is brought to the paper any solution which may tend to fall off in drops is struck off on the sides of the dish. All brush motions on the paper should be parallel, and in one direction, *i.e.*, the brush must not return along the same path. Quick work and even coating must be aimed at, and with a very little practice it is easy to obtain almost complete uniformity.

The best method of drying is to hang up overnight in a room where a fire has burned during the day, but the paper may be dried rapidly before a fire ; better only a glowing fire, as a flaming fire may fog the paper.

The exposure is longer than for ordinary silver papers, about double ; and can be most readily judged by looking through the paper. The coating should never be dense enough to materially affect the translucency of the paper, and consequently the faint image formed by the darkening of the bi-

chromated gum can be sufficiently distinguished to enable the exposure to be judged. The details in the shades should be just visible. The use of an actinometer is, however, preferred by some.

Developing the print is a very simple matter, a tin tray somewhat larger than the print, a plate of metal, or a board sloping gently down into the tray, a few soft brushes, and a small tin coffee-pot being all the appliances required. The print is first soaked in cold water, and its behaviour will soon give the clue to the next step, as in the event of under-exposure the colour will soon begin to wash off, especially if the tray is rocked or the water is repeatedly poured on the print from the coffee-pot; the print for this purpose resting on the sloping board or plate. In some cases cold water alone may finish the development, but ordinarily the temperature will have to be raised to about 90° F., by the gradual addition of hot water. In other cases much hotter water may be required, and as regards local treatment, the use of the steam from the coffee-pot and the soft brushes should be obvious enough. The former gains in detergency by the height from which it flows, and the brushes should, as a rule, only be used on the face of the print while well covered by water. When it is desired to wash off to an approximate line, a small stream from the coffee-pot, held at

arm's height, should be used; and a small strip of metal held at an incline half an inch over the line to be protected, will be found useful.

Those who have not been accustomed to carbon printing or other process depending upon the use of bichromate, will be somewhat put out by the widely varying sensitiveness of the film, and when the film is but slightly sensitive they will probably obtain hard prints with but little gradation of tone, and when the film is highly sensitive they will obtain soft prints and full gradation ; but the soft prints and full gradation depend rather on the exposure being suitable to the condition of the sensitive film than on the particular means adopted to give greater sensitiveness ; a quickly dried sample of the pigmented paper, prepared with a fresh sensitive mixture, will be at its minimum of sensitiveness, and may require an exposure of a quarter of an hour in sunshine with an average negative ; or very considerably more if the pigmented paper has been highly dried. If this paper be kept in the dark, and samples be tried from time to time, it will be found to increase in sensitiveness until insolubility sets in and the prints refuse to develop. This may happen in a few days if the weather is warm and damp, or not for months if the weather is cold and the paper is kept dry—in M. Marion's preservative receptacle, containing

chloride of calcium, for example, an appliance much used about half a century ago, and now revived as a means of preserving platinotype paper. Long contact of the gum bichromate in a moist state favours that preliminary change which results in greater sensitiveness and consequent obtaining of better half-tone with a short exposure; but all expedients for obtaining greater sensitiveness involve an increased risk of general insolubility. Dr. Holman, in a communication to the French Photographic Society, about three years ago, advocated keeping the sensitive mixture for twenty-four hours before using, and quite recently M. Demarchy suggests the use of a weak acid in the bichromate mixture. Both these expedients have been known to workers with bichromated colloids since the time of the Pretsch process in 1853.

The mixture as advocated by Demarchy is much thinner than that given above, and it is specially suitable for those who wish to prepare a stock of paper overnight for use in the morning. Being thin, the mixture is also more easy to wash over the paper.

According to Demarchy's method, the solution A, as given above, is replaced by the following :—

A bis.

Clear white gum	4 oz.
Citric acid	1 „
Water	15 „

OZOTYPE.

In issuing the fifth edition of CARBON PRINTING it becomes necessary to take notice of a new method of printing in pigment, a process brought to the notice of the photographic world by Mr. Thos. Manly, the principal purpose of which is that it shall constitute an auxiliary to the ordinary Carbon Process. At the Royal Photographic Society's Exhibition in 1898, Mr. Manly showed a few examples of his process under the name of Ozotype, but it was not until March of the present year that any communication as to the nature of the process was made, when Mr. Manly read a paper and demonstrated his process before the Royal Photographic Society on March 28th, and this paper constitutes up to the present the only authoritative information on the subject, so that our best plan will be to give Mr. Manly's paper in full, which is as follows :—

OZOTYPE WITH CARBON TISSUE: A NEW METHOD OF PHOTOGRAPHIC PIGMENT PRINTING WITHOUT ACTINOMETER, TRANSFER OR SAFE EDGE.

My communication to-night will deal with only a part of the uses to which a surface giving a photographic image in a high metallic oxide can be put.

It is my intention to describe what I consider the most important of its uses, namely, its employment in pigment printing, which is to my mind the most artistic method of making pictures by photography.

I will assume that all or most of you are familiar with the present process of carbon printing, and I will make only one remark with regard to that process ; namely, that it has been practised for over thirty years, and during that period no fundamental improvement appears to have taken place.

Amateur and professional photographers alike would heartily welcome a method of pigment printing where the image is plainly visible during exposure, and at the present time they feel certain misgivings in contemplating the extra work required in making a reversed negative or in going through a second process in order to correct the reversal of the image which, unfortunately, takes place in the present bichromated gelatine process. The process I have the honour to bring to your notice to-night overcomes both these difficulties and many others, and it is so unconventional and perhaps revolutionary in its conception that I hope I may be excused if I quote an extract from the Introduction to Professor Meldola's invaluable series of lectures on the Chemistry of Photography.

He says, in speaking of photography in general, " I am disposed to believe that the art is in danger

of outstripping the science. This is a state of affairs which we often witness when a discovery of immediate practical utility is made. There are many branches of industry which are now suffering in this country because they have been allowed to go on from the time of their foundation without any attention being paid to the scientific principles underlying them. It has been found by a long course of experience that certain results can be obtained in a particular way, and that mode of procedure has become stereotyped into a kind of article of faith. In such cases no trouble is taken to ascertain why the particular mode of operation leads to the desired result—the art here has outstripped the science . . . and we are running into the danger of seeing the industry taken out of our hands by more scientific competitors who have no stereotyped formulæ, and who have taken the trouble to investigate the why and wherefore of the different steps in their process."

How severely true these observations are, especially in regard to certain branches of British industry.

I should be very sorry to see the art of photography outstrip the science. Work that is not produced entirely by the hands must necessarily be based upon certain physical or chemical reactions which should be manifest to the worker if his aim

is to excel. It would be very desirable if the artist and scientist could be induced to regard one another as fellow workmen in the great workshop of the world. The scientist showing how the laws of nature could be so adapted that the genius of the artist could more readily produce a thing of beauty.

Now let us consider the subject before us.

The bichromate salts or chromic acid are the light sensitive agents in this process.

A bichromatic salt is chromic acid with a small amount of base ; and the action of light upon chromic acid is :—

$$\begin{aligned} &Cr_2O_6 + \text{light.} \\ &Cr_2O_3 + O_3. \end{aligned}$$

So you see the molecule of chromic acid is split up into a refractory oxide called sesquioxide of chromium and oxygen, which at the moment of its liberation is in a very active state, and which is probably what is known as ozone. Now the question is what becomes of the O_3 which light has thrown off? It must have been drawn away by some other attraction which is ready to combine with it.

It is my belief (and I am quite ready to be convinced by any better theory) that in the ordinary carbon process where the chromic salt is incorporated with the gelatine, the nascent or newly-liberated oxygen combines with and changes the

nature of the gelatine, and the sesquioxide of chromium formed at the same time gives it structure and strength to resist the prolonged action of hot water when minute quantities of gelatine are dealt with.

In Ozotype we make the active oxygen do work in another way. We make a solution of a bichromate salt and a manganous salt and coat paper therewith. The manganous salt is, in this case, the sensitiser, being the agent which receives the eliminated element. In the bichromated gelatine process the gelatine is the sensitiser. The action of light upon a surface consisting of a manganous and a bichromate salt would be that the eliminated oxygen would enter the molecule of the manganous salt and decompose it, producing an image in a high oxide of manganese, namely, the sesquioxide or manganic oxide, perhaps partly consisting of manganese dioxide.

So you see we have captured our active oxygen which has been placed by light in the position we desire, and we have locked it up for future use ; at the same time we have made our image visible and insoluble, so that all our unchanged salts can be easily washed out of the paper.

It must be borne in mind that only the acid light-sensitive compounds of chromium can be used. If the neutral chromates are added to a

manganous salt, decomposition immediately takes place, so there must be an excess of acid in the sensitive solution.

Having now produced what I may call a pleasing print of a light brown colour, the question arises, "How are we going to get the manganic oxide constituting the image to take up the pigmented gelatine of our tissue?"

I will show you a homely but very interesting experiment. We have heard a good deal lately of the policy of pin-pricks—I am going to show you an experiment in needle-pricks. I have here some carbon tissue which I have soaked in a 2 per cent. solution of acetic acid, and into this I have stuck some needles and have allowed the gelatine to dry. I will plunge it into hot water and develop it. You will see that a ring of insoluble gelatine is formed round each needle. The iron has been oxidised and the contiguous gelatine has been rendered insoluble. If we use high metallic oxides the phenomenon is the same. The gelatine is changed and has been rendered comparatively insoluble. If we dip our carbon tissue into a dilute solution of acetic acid and squeegee it on to our manganic oxide print, we shall get a picture; but the very minute portions of gelatine constituting the details will be washed away by the continued action of hot water.

We must, therefore, seek for something that acts

in the same manner as the sesquioxide of chromium in the ordinary carbon process to which I have already referred—something that will give substance and strength to the changed gelatine, so that it may be able to resist the rough treatment of development in hot water. For this purpose we have at our command some very useful compounds, viz., the now widely-used phenol-derived photographic developers, such as hydroquinone, pyrocatechin, metol, pyrogallol, etc., which have strong tanning properties in the presence of oxygen. Very small quantities of such substances added to about one-half per cent. solution of acetic acid will make a bath, in which we can immerse our carbon tissue and lay it down on our print, and feel sure that if the proportions of the ingredients and the amount of oxide in the print are correctly judged, we shall produce a picture possessing all the half tones and details of our negative.

For want of a better term I will refer to the solution into which we immerse our carbon tissue, as the acetic solution.

For well printed proofs from good negatives, I find the following formula useful :—

Water	... ...	1,000 cubic centimetres.
Glacial acetic acid	...	3 to 5 „ „
Hydroquinone	...	½ to 2 grammes.

A variety of effects may be produced by modifying the quantities of the ingredients—the addition of acetic acid in very small quantities producing contrast, and increase of hydroquinone giving soft effects, or the hydroquinone may be decreased instead of increasing the quantity of acetic acid and so on.

The only apparatus necessary is :—

Developing tank with a small gas or oil stove, such as is used for a kettle.

Squeegee.

Porcelain dish for acetic solution.

Flat surface of *papier maché* or other material for squeegeeing.

Dark room pins with which to hang the prints up to dry.

A piece of zinc, a little larger than the print, to form a stiff backing during the operation of development.

The method of procedure is as follows :—

Print until the details in the high lights are visible. The sensitive paper is quick in printing, being, I should say, about the same rapidity as platinotype paper, but of course you all know everything depends upon the opacity of the negative. The progress of printing out is distinctly visible, so that nothing is left to guess-work.

When the proof is printed, it may be washed

at once, or deferred until the day's printing is over.

The washing is very easy and certain, as the colour of the water is a guide in this operation. When the water is quite colourless, the prints are ready for drying. About three changes of water are usually quite sufficient to dissolve out the unchanged salts. The carbon tissue, cut to size, is now immersed under the surface of the acetic solution contained in a porcelain dish, and allowed to remain one minute. The temperature of this solution should not be less than 65° Fahrenheit and not higher than 75°. The print is then plunged under the surface of the same solution and brought into contact with the gelatine surface of the carbon tissue and both are drawn out, clinging together, and squeegeed down upon a flat surface. They are then surface-dried between blotting paper and hung up to dry. When dry, the print with its adherent carbon tissue is placed in cold water for not more than half-an-hour, when it is ready for development. This is performed by taking the print out of the cold water and plunging it in water at a temperature of about 102° to 105° Fahrenheit, and letting it remain for about one minute, when the backing or the tissue can be removed.

This operation differs somewhat from the ordinary carbon process, inasmuch as the backing requires

to be peeled off with gentle force ; but when once the backing is got rid of the development proceeds upon the same lines as in the ordinary carbon process.

There are various methods by which we could make the process of development easier, for instance, we could add magnesium sulphate, calcium chloride, barium chloride or glycerine to the acetic solution, without in the least affecting the action, and the tissue would not require so much soaking in cold water, and the backing would be less difficult to remove.

I am sorry that owing to the very small amount of leisure time at my disposal, I have been unable to make many experiments, but the subject is such an important and interesting one that it is worth anybody's while to make further investigations into the oxidation of gelatine.

We have in this process the same chemical actions occurring as in the bichromated gelatine process, the nascent oxygen changing the nature of the gelatine in both cases, and a phenol hydroxide enabling the oxidised gelatine to resist the action of hot water in the same way as the sesquioxide of chromium in the present carbon process.

The advantages of such a method as I have brought to your notice are obvious.

The sensitive surface is on the paper which will form the permanent support of your picture. The progress of printing can be observed, and the print-out image in point of visibility comes next to that obtained from chloride of silver. After the print is washed it will keep almost indefinitely.

The printing is rapid and the sensitive paper will keep good for three months or more without any special precaution. I may say that I have obtained a print on paper that has been kept in a sensitive condition for eleven months. You can pigment months after you have obtained and washed your print. You get no reversal of the image in regard to right and left, and no safe edge is necessary. You can alter the character of your print by varying the quantity of the ingredients in the solution in which you soak your carbon tissue ; and in the operation of development your hands and fingers do not come in contact with a deleterious solution. Owing to the carbon tissue being in a soluble condition the squeegeeing is a very easy operation, and for the same reason air bells imprisoned between the print and tissue do not produce blisters.

In the selection of paper for sensitising, I find single transfer paper excellent, and moderately sized papers, such as Whatman, Arnold, or cartridge work admirably if the washed print be coated

with a two per cent. solution of soluble gelatine, the result being that only the deep shadows show a gloss. Thickly gelatinised baryta paper can also be sensitised, and of course the details on such a surface are very delicate.

In working this process almost any effect can be obtained. If you admire the green bichromate style you can print on rough paper by adding a certain quantity of calcium chloride to the acetic solution, you will get that "running down" effect which some artists commend.

As the gelatine is not so refractory as in the present carbon method you can easily put in clouds if you have an artistic finger, or you can locally wash away gelatine with hotter water to obtain high lights. If you want deep shadows, a one per cent. solution of alum brushed over the portion of your picture which you wish to preserve will give the desired effect.

I am sorry I have only had a few hours a week in the evening to devote to the subject, yet my experiments, conducted in my own little dark-room in a crude and homely fashion, with no special apparatus at my command, have revealed several remarkable chemical actions which have quite fascinated me, and when I have gained a little more knowledge of the manipulation than I possess at present, I am confident that a particu-

larly easy and certain process for producing photographic pictures in artist's colours, will be placed within bands.

Some questions and comments which were offered by some of the members present at the above lecture elicited some further hints from the lecturer.

The proportion of manganous salt to bichromate for the sensitising solution is as follows :—

Manganous sulphate	... ...	14 parts
Potassium bichromate	... ...	7 ,,
Water		100 ,,

Cobalt may be substituted for manganese, but it gave a less visible image. The sensitising solution may be applied by a brush or by immersing the paper.

The two per cent. gelatine solution is only necessary with rough paper, and is to be applied after the manganic print has been washed and dried; its object being to secure the adhesion of the carbon tissue ; in such a case the print should be rather darker than usual.

As to developers, metal has been found to work very well, also pyrocatechin, but Mr. Manly does not approve of the amido derivatives because of their liability to produce colour. Pyrogallol has

a fault which, however, may be turned to account, and that is that it stains the paper a buff, and in some cases has been wonderfully successful in imparting to the platinotype print the appearance of an old print or engraving.

Chromic acid may be substituted for bichromate.

It has been remarked that one drawback to the ordinary carbon process was the greasy appearance of the surface of the print, especially in the shadows, due to a great extent to the excess of gelatine over the pigment in the tissue ; and Mr. Manly was asked if he had tried a tissue less thickly coated with gelatine than that ordinarily obtainable ?

In reply, Mr. Manly said a thinly coated tissue would be preferable, and it must not contain an excessive proportion of pigment. He thought prints might be made upon opal by gelatinising the opal before sensitising. To remedy under-exposure he would wash the print and treat it with a solution of chloride of lime, which would probably convert the sesquioxide into a higher oxide yielding a stronger print ; or a stronger acetic solution might be employed. The prints were amenable to reduction by local treatment with hotter water.

Whilst of course Mr. Manly has protected his process from piracy by provisional patent, and will

in all probability at a later date take steps to place the manufacture of the manganic paper on a commercial basis in order that it may be sold at a popular price, yet in the meantime he is very willing to help those interested in experimenting with the paper, and will be glad for amateurs and investigators to make every use of the formulæ he has published and make and scrutinise the paper in order that the process may receive the full benefit of numerous experiences.

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